Space Weather Technical Forecast

Issued on Saturday, 03 December 2022 at 13:01 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Active high energy electron fluence. Daily chance of M-flares. Slight chance G1 Minor Storms, mainly early day 2 (4th) with any CME arrival or late day 4 (6th) with HSS arrival.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar Activity has been Low in the last 24 hours, with several C-class flares. Peak flare was an C2.3 at 03/1110 UTC, this was from an emerging area on the northeast limb. There are six regions currently on the visible disk, AR3153 remains the largest feature on the disc, as a large and mature open group. AR3155 in the north centre disk has seen recent intermediate spot development but remains magnetically simple. AR3156 in the northeast persists as a modest sized stable unipolar spot. AR3154 in the southwest persisted as a small bipolar group and there remain two new regions in the northeastern quadrant, both of which are currently small and simple. Ex-AR3152 in the northwest has faded to plage.

No Earth-directed CMEs were observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind was indicative of a declining fast solar winds from a coronal hole. Wind speeds have been Elevated to Strong, with ACE showing wind speeds peaking at around 730 km/s, before declining to below 700km/s near the start of the period, with a gradually reducing trend towards current Elevated speeds of around 500-600km/s. Total IMF Bt was generally weak between 2 and 5nT. The north-south component Bz was variable between -5nT and +4nT. Phi angle was largely positive throughout (Away from the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 2-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES-16 has remained at Background levels. High energy electron flux (greater than 2MeV) at GOES-16 has been High throughout, peaking at 8780 pfu at 02/1915 UTC. The associated 24 hour Fluence was above the Active (1e8 integrated pfu) threshold throughout. Observed fluence at 03/1200 UTC was 4.50e8 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is forecast to be Low, with further C-flares expected, and a daily chance of rising to Moderate with isolated M-flares possible. A very slight chance of isolated X-flares throughout, primarily from AR3153 but also from areas rotating on from the northeast limb.

Solar Wind / Geomagnetic Activity: A slow CME from 29th Nov may arrive at Earth early on day 2 (4th) +/- 9 hrs. Ongoing fast wind environment is expected to gradually fade through the period easing to perhaps slightly elevated by the end of day 1 (3rd). The fast wind from CH53/- may arrive at Earth from late day 4 (6th), with solar wind speeds perhaps reaching in the region of 550-650 km/s. Quiet to Unsettled with chance of Active intervals are expected through the period. Any CME arrival will bring the chance of a further spell of Active to G1/Minor Storm intervals from late day 1 (3rd) or more likely early day 2 (4th), with the risk reducing by day 3 (5th). Day 4 (6th) may see an early arrival of CH53/-, with only a slight chance of G1/Minor storming due to being a negative feature.

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Met Office Space Weather Technical Forecast

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES-16, is expected to remain at Background throughout. High energy electron flux (greater than 2 MeV), as observed by GOES-16, is expected to remain predominantly High with Fluence levels persisting above the Active (1e8 integrated pfu) fluence threshold.

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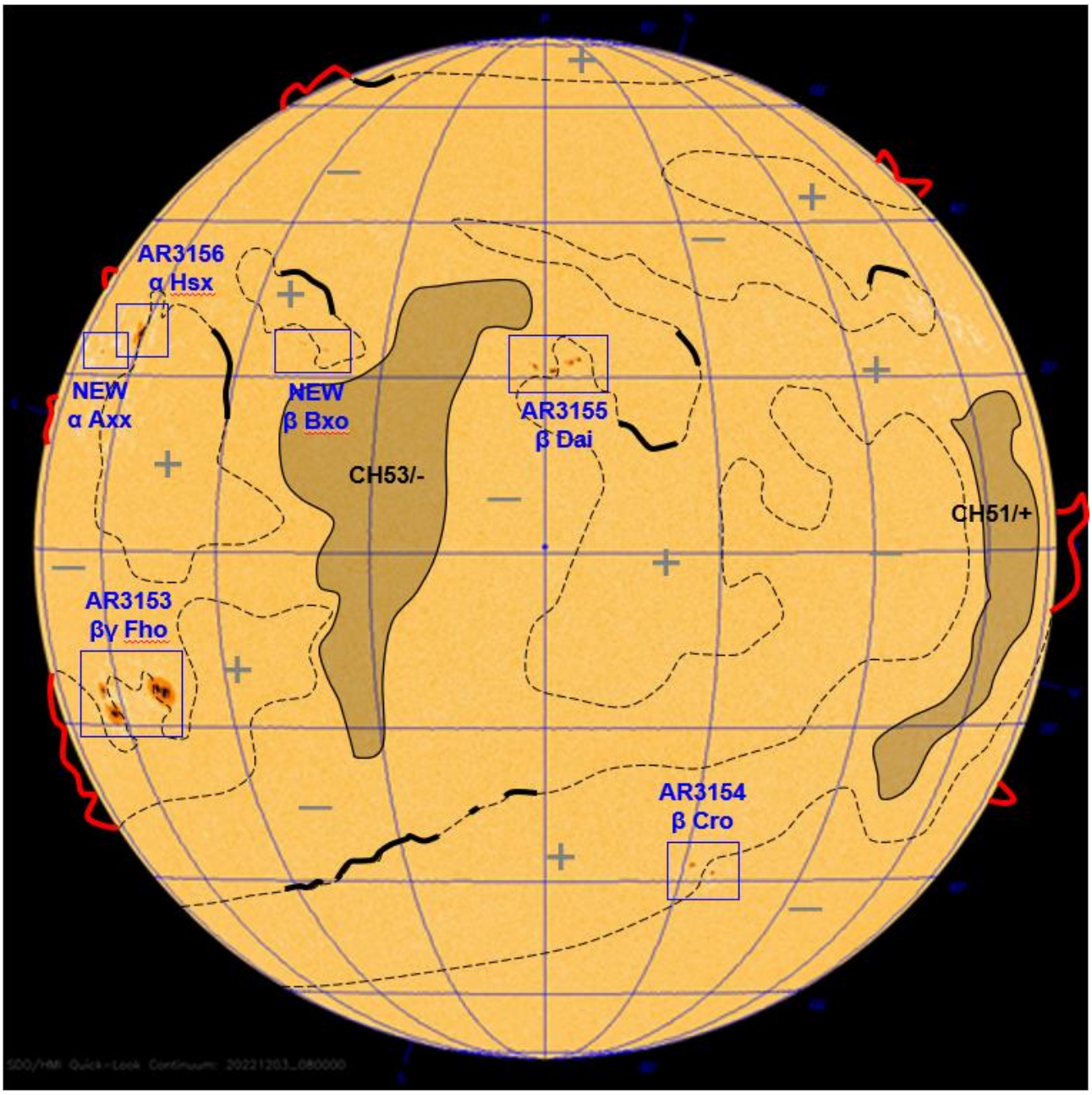
Figure 1. Solar Analysis Valid 03/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A filament eruption on 29 Nov, and its associated CMEs have been assessed as slow, but with the possibility of Earth-directed components, although this is low confidence. MOSWOC ENLIL output suggesting any arrival is most likely to occur early day 2 (4th), perhaps very late day 1 (3rd). The CME from the M1 flare of AR3152 at 01/0721 UTC is expected to miss, passing to the north and ahead of Earth though some element of interaction is possible.

Ongoing fast wind environment is expected to gradually fade through the start of the period as indicated by MOSWOC ENLIL. The 27-day persistence also indicates a gradual decline, albeit slightly faster, with solar winds around 400 km/s by late day 1 (3rd). However, CH51 was a larger feature on this rotation supporting to the forecast from the Enlil model.
Toward the end of the period, the fast wind from CH53/- may arrive at earth. It's current location is to the east of the meridian, therefore giving an arrival of late day 4 (6th) or perhaps after, with solar wind speeds perhaps reaching in the region of 550-650 km/s. This is yet another feature that appears darker and larger than on the previous rotation, therefore giving faster speeds than previously seen. However, due to this coronal hole being a negative feature, it is less likely to have a geomagnetic impact at Earth.

Quiet to Unsettled with chance of Active intervals are expected through the period. Any CME arrival will bring the chance of a further spell of Active to G1/Minor Storm intervals from late day 1 (3rd) or more likely early day 2 (4th), with the risk reducing by day 3 (5th). Day 4 (6th) may see an early arrival of CH53/-, with a slight chance of G1/Minor storming.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	20	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
25/1904	Partial	Filament	Central S Hemisphere	630 km/s	04/0600 UTC	Low confidence

Figure 2: latest MOSWOC ENLIL output, showing CME signal early 4th.

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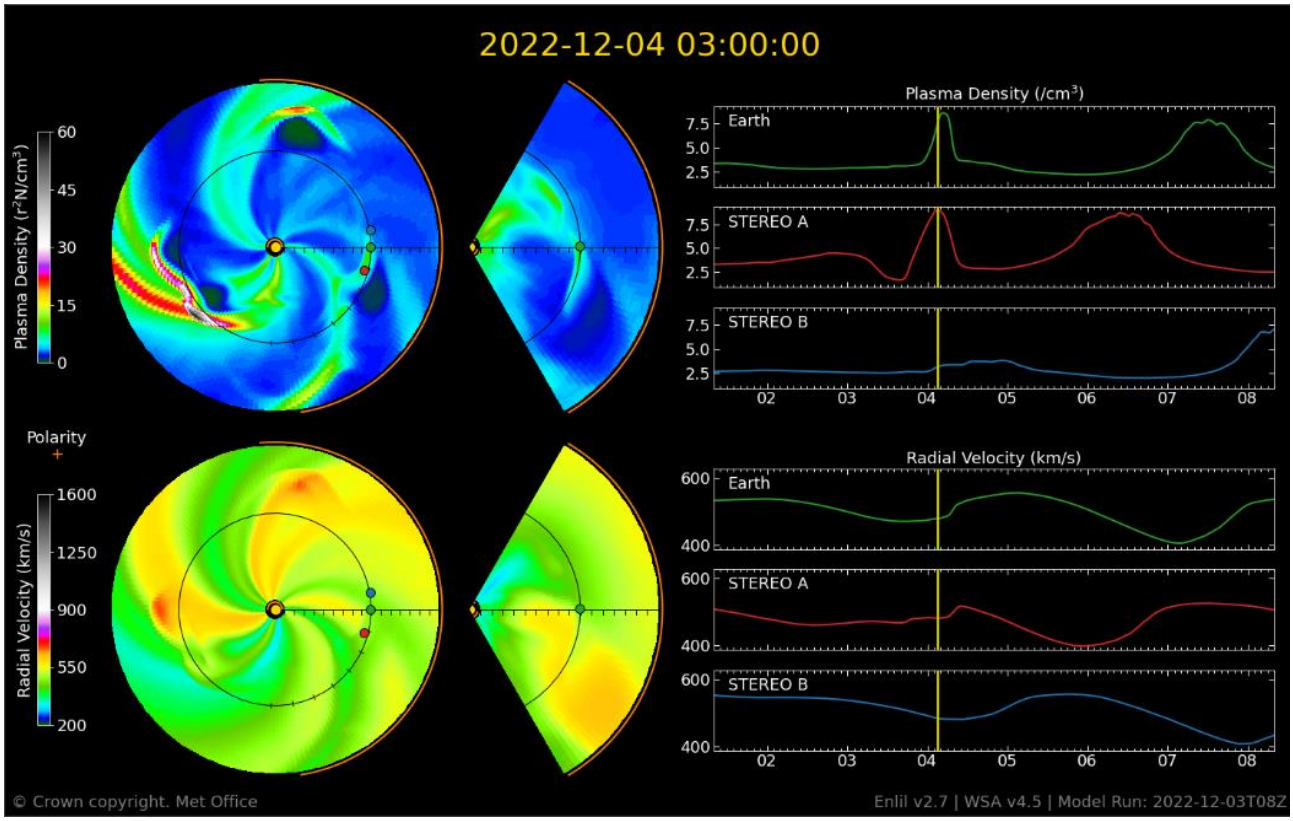

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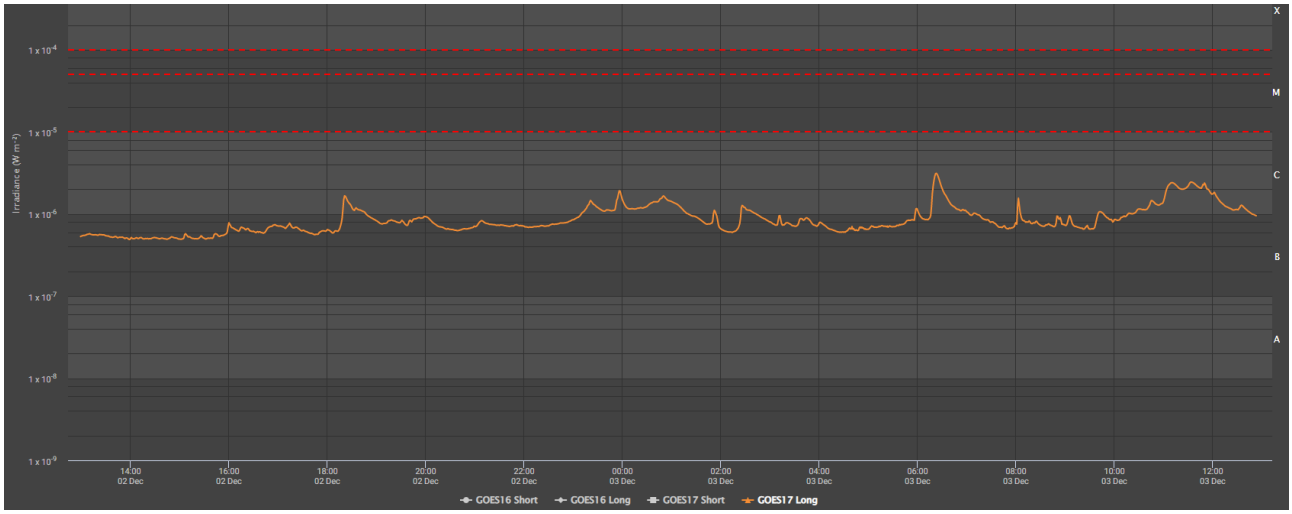
Radio Blackouts - X-Ray Flares:
Solar activity is forecast to be Low, with further C-flares expected, and a daily chance of rising to Moderate with isolated M-flares possible. A very slight chance of isolated X-flares throughout.

AR3153 Fho/Beta in the southeast remains the main feature, a relatively simple, albeit large spot with a mature and currently stable bipolar east-to-west aligned field. Despite this, the spot does contain a large amount of potential energy giving the potential for notable flaring should any destabilisation occur.

There are five other sunspot region. Of the two central disc regions AR3154 Cro/Beta in the south looks to be fading, but AR3155 Dai/Beta in the north has seen recent intermediate spot development, with a increase in flare risk. AR3156 Hsx/alpha near the northeast limb appears to be a mature spot, set amongst a bright area of plage and a single NEW Axx/Alpha, and further active regions rotating onto the disc given the bright signal for this area on STEREO A euvi and recent flare activity, precise analysis remains hard given current position. The significant amount of potential energy in this region helping to increase flare probabilities through the period as a precaution however before these areas fully rotate onto the visible disk and a full assessment can be made. One additional NEW, simple region in the northeast quadrant currently analysed as a Bxo/Beta but tending to fade. Ex-AR3152 Bxo/Beta in the northwest now faded to plage

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	25	25	25
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: 24hr GOES17 Long X-Ray trace.



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Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES16, is currently at background levels and is expected to remain at this level throughout the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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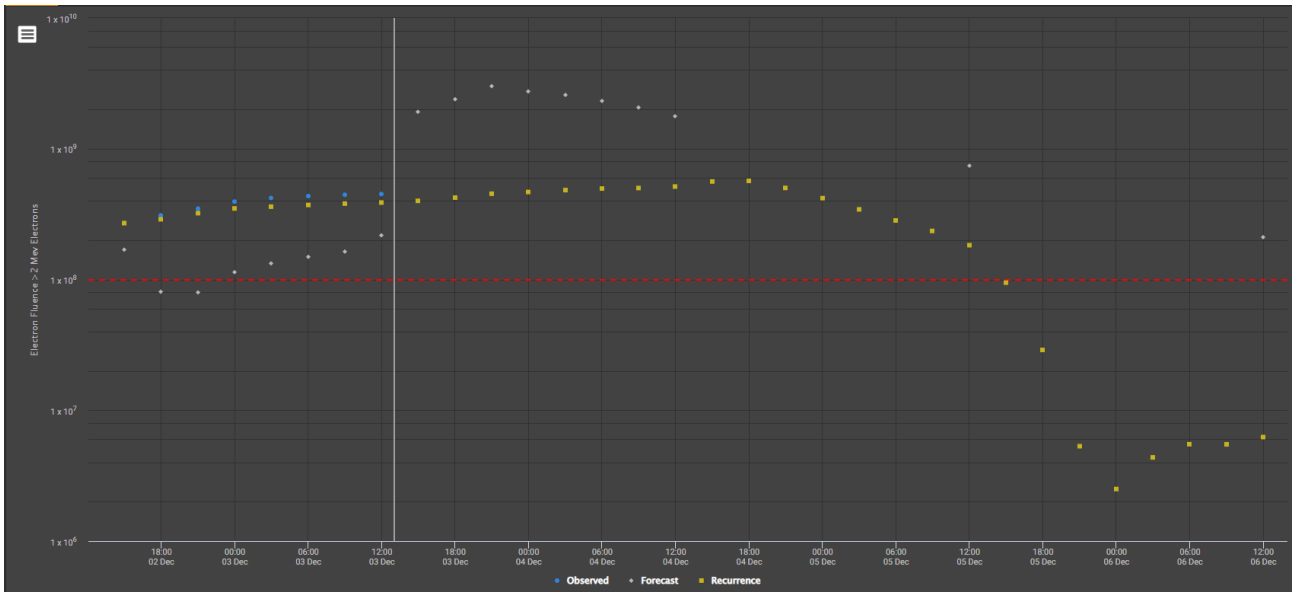
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2 MeV), as observed by GOES16, is currently at High levels (above 1000 pfu) and expected to persist at this level for much of the period, with a potential increasing trend. There is a chance of a drop out early day 2 (4th) due to any potential CME arrival.

Consequently the associated Fluence levels are currently above the Active (1e8 integrated pfu) and are expected to increase through the following days as the HSS wanes. Confidence is high that the fluence will remain predominantly above Active with only a slight reduction in confidence later in the period. REFM has struggled to handle the recent fast wind arrivals, however it is now giving good guidance for Active fluence to persist.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	90	80	80
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	10	10	10	5

Figure 4: Latest MOSWOC REFM model giving reasonable guidance.



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